COURSE TITLE	**ADVANCED MACHINE DESIGN**
COURSE CODE	**01ME2711**
COURSE CREDITS	**4**

Objective:

1 The course is intended to strengthen fundamentals of applied mechanics of solids and help understanding design and analysis of machine components under variable loading. The course explains design procedure and analysis of machine components at elevated temperature. The course teaches fundamentals and application of fracture mechanics and surface failures in mechanical component design.

Course Outcomes: After completion of this course, student will be able to:

1 Apply various theories of failure to design mechanical components subjected to static and combined loading conditions.

2 Analyze fatigue behavior, estimate fatigue life, and assess the effect of mean stress and loading conditions on component durability.

3 Analyze fracture mechanics parameters such as stress intensity factor and crack propagation to evaluate structural integrity.

4 Evaluate creep behavior, time-temperature effects, and predict component life under high-temperature and long-term service conditions.

Pre-requisite of course: Fundamental of Machine Design, Machine Design – I, Machine Design - II

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Review of stresses, Strains and Theories of Failures** Introduction, Plane Stress, Rotation of Coordinate Axes, Generalized Plane Stress, Principal Stresses and Maximum Shear Stress, Three-Dimensional state of stress, Stresses on Octahedral plane, Plane strain, Strain gage rosettes., Introduction to basic Constitutive Relations and Rheological Models: Elastic Model-Generalized Hooke's Law, Plastic model Rigid-Perfectly Plastic, Elastic-Perfectly, Elastic-Linear Hardening, Anisotropic and Orthotropic Hooke's Law, Different Theories of Failures: Distortion Energy, Maximum-Shear Stress, Maximum Normal Stress, Modified Coulomb-Mohr Theory, Comparison of theories of failures.	11

Contents : Unit	Topics	Contact Hours
2	**Fracture Mechanics** Introduction to fracture mechanics, Increase in stresses due to crack, displacement due to Crack tip opening, Effect of crack on strength of ductile and brittle material, Crack opening modes and Griffith theory, Concept of Stress Intensity Factor, Plasticity at Crack Tip, Use of Stress Intensity Factor in design and analysis, Determination of plastic zone, size and shape.	10
3	**Fatigue** Introduction, factors affecting fatigue behavior, Theoretical stress concentration factor and notch sensitivity factor, Fatigue under complex stresses, cumulative fatigue design, Linear damage (Miner's Rule),, Manson's method, Fatigue crack propagation and life estimation for constant and variable amplitude stress., Fatigue considering Strain: Strain Vs Life Curve, Strain-Life Equation, effect of Mean stress, Life estimate for structural components.	12
4	**Creep** Creep phenomenon, Creep Curve, concept of True stress and true strain, Creep parameters, time-temperature parameters and life estimate under creep., Stress relaxation. Stress-Strain-Time relation, Creep deformation under varying stress, Component stress-strain analysis.	9
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**To analyze stress concentration effect on a specimen using software.** To analyze stress concentration effect on a specimen using software.	2
2	**To perform stress concentration test of a specimen using Universal Testing Machine.** To perform stress concentration test of a specimen using Universal Testing Machine.	2
3	**To analyze fatigue failure of a specimen using software.** To analyze fatigue failure of a specimen using software.	2
4	**To perform fatigue failure test of a specimen using fatigue testing machine.** To perform fatigue failure test of a specimen using fatigue testing machine.	2
5	**To analyze creep failure of a specimen using software.** To analyze creep failure of a specimen using software.	2
6	**To investigate creep failure of a specimen using microscope.** To investigate creep failure of a specimen using microscope.	2

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
7	**Prepare a case study related to selection of material and manufacturing process of any mechanical components.** Prepare a case study related to selection of material and manufacturing process of any mechanical components.	2
8	**Prepare a case study related to design of mechanical components.** Prepare a case study related to design of mechanical components.	2
9	**Prepare a case study related to failure of mechanical components.** Prepare a case study related to failure of mechanical components.	2
10	**Design exercise of shaft used in machine tool gear box.** Design exercise of shaft used in machine tool gear box.	2
11	**Design exercise of connecting rod used in Automobile I.C. Engine.** Design exercise of connecting rod used in Automobile I.C. Engine.	2
12	**Design exercise of cylinder used in Automobile I.C. Engine.** Design exercise of cylinder used in Automobile I.C. Engine.	2
Total Hours		**24**

Textbook :

1 Machine Design: An Integrated Approach, Norton, Pearson Education., 2010

2 Fundamentals of Machine Design, R C Juvinall & K M Marshek, Wiley India., 2005

3 Dislocations and Mechanical Behaviour of Materials, M. N. Shetty, PHI., 2002

References:

1 Metal Fatigue in Engineering, Metal Fatigue in Engineering, R I Stephens, A Fatemi, R R Stephens and H O Fuchs, John-Wiley, 2015

2 Elements of Fracture Mechanics, Elements of Fracture Mechanics, Prashant Kumar, McGraw-Hill., 2018

3 Mechanical Behavior of Materials: Engineering Methods for Deformation Fracture a Fatigue, Mechanical Behavior of Materials: Engineering Methods for Deformation Fracture a Fatigue, Dowling, Pearson Education., 2019

4 Mechanical Behaviour of Materials , Mechanical Behaviour of Materials , T H Courney , McGraw-Hill / Overseas Press India , 2006

5 Mechanical Design of Machine Elements and Machines , Mechanical Design of Machine Elements and Machines , H Busby and G Stabb , Wiley India , 2000

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	10.00	20.00	15.00	25.00	20.00

Instructional Method:

1 PPT
2 Videos
3 Animations

Supplementary Resources:

1 https://nptel.ac.in/courses/112/106/112106137
2 https://amesweb.info/Calculators.aspx